Applications Of Ozone In Dentistry

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Abstract

Ozone is a colorless gas form of oxygen and is present in atmosphere. It is a powerful oxidizer. It effectively kills bacteria, fungi, viruses and parasites at a dramatically lower concentration. It is a great supplement to conventional therapeutic dental modalities. Treatment may be achieved by increasing the resistance of the tooth against the microbial activity and reducing the extent of microbial activity. In addition to the recent materials and techniques, the therapeutic actions of ozone may provide beneficial results by reducing the demineralization of the tooth. Ozone unit was developed under the name 'Heal Ozone' by Kavo – Dental Gmbh and Co. Ozone finds its place in all disciplines of dentistry. The treatment is completely painless and increases the patient's acceptability and compliance with minimal adverse effects, thus making it an ideal treatment choice for pediatric patient's where patient compliance is the key to its success.

KEYWORDS: Ozone, Oxygen, Dentistry.

Introduction

Atmospheric air is made up of nitrogen (71%), oxygen (28%) and other gases (1%) including ozone which is altered by processes related to altitude, temperature and air pollution (1,2). Ozone (O_3) which has a characteristic, penetrating odor is present in small amounts in atmospheric air. Ozone molecules are composed of three oxygen atoms and present naturally in the upper layer of atmosphere in abundance as long as sun is shining (1,3,4). It protects living organisms by surrounding the earth at altitudes of 50,000 to 100,000 feet from the ultra-violet rays (1,2). As it falls downward to earth, being heavier than air, combines with any pollutant it comes in contact with and cleans the air. This is earth's natural way of self-cleansing (3).

Medical Ozone is made when medical grade oxygen is electrically activated (using an Ozone Generator) to form ozone (3). It is a mixture of the purest oxygen and purest ozone. According to its application, the ozone concentration may vary between 1 and 100 µg/ml (0.05-5%). The ozone therapist determines the complete dosage according to the medical/dental indication and the patient's condition (5, 6).

Ozone is an unstable gas and it quickly gives up nascent oxygen molecule to form oxygen gas. The release of nascent oxygen has beneficial effects on every part and organ (1). It has been used in medical field since long due to its extremely strong oxidant property that oxidizes nearly all surfaces to the highest oxidation stage. It is used as a circulatory enhancement and stimulation of oxygen metabolism, disruption of tumor metabolism and to kill pathogens (1,2). O_3 is a powerful oxidant capable of interacting as metabolic & immune modulator as well as anti-microbial agent. Multiple microbiological & the biochemical studies justified that there are no doubts about the effectiveness of ozone in bacterial reduction (7). Among other things, ozone is used to purify drinking water and water in dental equipment and for sterilizing instruments for medical use (8).

HISTORY (1, 2, 3)

- Christian Friedrich Schönbein (1840), a German Chemist, is regarded as the Father of ozone therapy. When he passed an electrical discharge through water, a strange smell was produced, which he called Ozone, derived from the Greek word **'OZEIN'** which means odor.
- In 1857 Joachim Hänsler, a German physicist and physician, along with German physician, Hans Wolff, developed the first ozone generator for medical use.
- In 1860,Monaco first used it in water treatment plants
- Dr. C. Lender in 1870. He purified blood in test tubes by using O_3 . Later, O_3 application gained as a popularity as a therapeutic procedure throughout Europe and America.
- In 1881, it was used as a disinfectant in the treatment of diphtheria.
- Dr. Charles Kenworthy, a Florida physician, in 1885, published his experiences with ozone in the Florida Medical Association Journal
- In October 1893, Ousbaden, Holland became the first city to utilize a water treatment plant using ozone. In World War I and II it was used to treat wounded soldiers in the trenches
- In early 20th century Food and Drug Act, revised its use and effect in the field of medicine.
- A German dentist, Dr. E.A. Fisch, in 1950, used ozonated water for dental procedures and pioneered its use in medicine.

MECHANISM OF ACTION OF OZONE

Ozone gas is produced (8):

- From electrical discharges following thunderstorms. Ozone is created when an oxygen molecule receives an electrical discharge breaking it into two oxygen atoms. The individual oxygen atoms combine with another oxygen molecule to form O_3 molecule.
- From ultraviolet rays emitted from the sun which plays the role of electrical discharge over oxygen present in the stratosphere thus, creating the ozone layer which absorbs most of the ultraviolet radiation emitted by the sun.
- In the clinical setting, an ozone generator stimulates lightning via an electrical discharge field.

Ozone is theorized to act by (9):

1. Killing bacteria at the carious lesion and

2. Oxidizing organic material within the carious dentin

Ozone in the gaseous or aqueous phase has been shown to be a powerful and reliable antimicrobial agent against bacteria, fungi, protozoa and viruses. It is generally accepted that the oxidant potential of ozone induces the destruction of cell walls and cytoplasmic membranes of bacteria and fungi. During this process, ozone attacks the glycoproteins, glycolipids and other amino acids and inhibits and blocks the enzymatic control system of the cell. This results in increase in membrane permeability, the key element of cell viability, leading to immediate functional cessation. Then ozone molecules can readily enter the cell and cause the microorganism to die.

Ozone can attack many biomolecules, such as the cysteine, methionine and histidine residues of proteins. By oxidizing the biomolecules featured in the dental tissues, ozone has severely disruptive effect on cariogenic bacteria, resulting in the elimination of acidogenic bacteria. The strongest naturally occuring acid produced by acidogenic bacteria during cariogenesis is pyruvic acid. Ozone can decarboxylate this acid to acetic acid. It has been shown that remineralization of incipient carious lesions can be encouraged when the production of acetic acid or other high pKa acids found in resting plaque, buffers plaque fluid.

USES OF OZONE:

The reliable microbiological and metabolic properties of ozone, in either the gaseous or aqueous phases make it a useful disinfectant with a wide range of activity (9).

Major industrial uses of ozone:

- Disinfectant agent in drinking water and air
- Equipment sterilization
- Treating industrial wastes
- Rapid drying of varnishes and printing inks
- Disinfect agent of food in cold storage
- Bactericide
- Prevent the growth of yeast and mould in fruit storage
- Removal of chlorine from nitric acid
- Producing steroid hormones
- Oxidation of phenols and cyanides

AS APPLIED TO PEDIATRIC DENTISTRY:

Ozone has got its role in various dental treatment modalities. Ozone therapy presents great advantages when used as a support for conventional treatments.

TREATMENT OF DENTAL CARIES (10)

The provision of dental treatment for young people can have long lasting effects. If dental care is painful and unpleasant, as these patients grow into adults, they will tend to only attend when in pain. As all dentists know, at this stage restorative care tends to be more difficult, more extensive and has increased cost implications. The use of ozone and mineral releasing glass ionomers can play a

significant role in the dental management of such child patients.

Treatment of caries with ozone is simple, fast and involves little preparatory work. The loose debris is first cleaned away, until a leathery base is reached. This can be done with hand instruments. Ozone is applied, the lesion wetted with the CurOzone (CurOzone Canada Inc) remineralising wash and then the glass ionomer can be applied.

RESTORATION OF LARGE CAVITATIONS ALONG WITH CONVENTIONAL CONSERVATIVE MEASURES (11)

The larger lesions need special care. It must be stressed that larger lesions are not those to be treated with ozone alone; most will require a combined approach of traditional therapy, as well as ozone. As before, the aim is to allow natural remineralisation to take place on a predictable basis, without the wholesale destruction of tooth tissue. Where the lesion extends deep into the dentine, the action of ozone will take a longer time period of treatment, or may require several treatment periods over time. The basic protocol is the same; the soft debris is removed along with any unsupported enamel. If possible, denatured dentine is removed to the leathery layer. Ozone is applied from 40 seconds or longer. Some practitioners are using 2 to 3 minutes for large deep lesions that extend on x-ray almost to the pulp chamber. Then, the remineralising wash is applied.

There are two options of choice at this stage of treatment that HealOzone practitioners are using;

a. The lesion is left as self cleansing, and the patient is instructed with modified oral hygiene instructions. After routine brushing and rinsing, they are asked to place a small amount of the paste directly into the cavity. Then they spray two puffs of the remineralising solution directly into their mouths. This is repeated at least three times each day.

b. The lesion is restored using a mineral-releasing glass ionomer, such as FujiVII or a resin-bonded composite. This will allow demineralization to occur, without the possibility of ingress of food debris and re-colonization of the cavity.

It must be stressed that it is vital to control patient's expectations.

REMINERALISATION OF PIT AND FISSURE, ROOT AND SMOOTH SURFACE CARIES (12)

In superficial root caries or early pit and fissure carious lesions, ozone alone may be sufficient to treat these lesions. However, in situations where severe breakdown of tooth structure has occurred, ozone may be used initially to promote remineralization and when this has occurred the cavity may be restored with a suitable restorative material.

BLEACHING (1)

In root canal treated teeth, crown discoloration is a major aesthetic problem, especially in anterior teeth. Conventional walking bleach requires much more time and results are not often satisfactory. Also, capping the tooth with ceramic crown is not always a good idea. But, now ozone has the answer to all these questions. After placing the bleaching agent the crown is irradiated with ozone for minimum of 3-4 minutes. This ozone treatment bleaches the tooth within minutes and gives the patient a happy and healthier-looking smile.

ENDODONTIC TREATMENT

The aim of conventional root canal therapy is to provide a clean, shaped, root canal that facilitates the placement of an adequate root filling. There may be multiple canals, frequently linked by a "web" of accessory canals. There is the so-called "apical delta" and the common lateral canals. Until recently, the dental profession relied on irrigants reaching these areas to disinfect and dissolve organic debris where it is impossible to instrument mechanically.

In this situation, current procedures can again be modified, as with whitening, to greatly improve the quality of treatment for patients. When irrigating with the usual irrigant solution, for example sodium hypochlorite, ozone can be applied to the hypochlorite solution in the root canals. This technique allows the root canal system to be thoroughly disinfected and possibly be sterilized. In cases where previous root canal treatment has failed, *Enterococcus faecalis* seems particularly prominent and especially difficult to eradicate. Ozone will eliminate this bacterial type (13). It is also postulated that ozone will penetrate through the apical foramen, and enter into the surrounding and supportive bone tissue. The effect of ozone on these tissues will be to encourage healing and regeneration (14).

DENTAL OZONE GENERATORS;

HEAL OZONE (15)

The ozone unit for dental use was initially developed by CurOzone Inc. (Canada) and subsequently manufactured under license and distributed by KaVo-Dental GmbH & Co. (Germany) under the name 'HealOzone'. Its use has been pioneered by Professor Edward Lynch and his team at Queen's University in Belfast, Northern Ireland, and Barts and the London Queen Mary's School of Medicine and Dentistry in London, UK.

HealOzone procedure

The HealOzone procedure consists of a package which includes:

- The application of ozone gas
- The use of remineralizing agents
- A patient kit
- Information on oral hygiene.

The HealOzone device comprises

- An air filter
- A vacuum pump
- An ozone generator
- A handpiece fitted with a sealing silicone cup and a flexible hose.

The procedure usually takes between 20 and 120 seconds per tooth. Immediately after ozone application the tooth surface is treated with a remineralising solution (reductant) containing fluoride, calcium, zinc, phosphate and xylitol dispensed from a 2-ml ampule.

Patients are also supplied with a patient kit, which consists of toothpaste, oral rinse and oral spray, all containing fluoride, calcium, zinc, phosphate and xylitol, and aims to enhance the remineralisation process. HealOzone application for the treatment of non-cavitated lesions is usually repeated at 3 and 6 months.

ADVANTAGES (16)

- HealOzone treatment of dental caries removes the requirement for physical removal of diseased tissue and promotes remineralisation.
- Extremely time efficient
- Provide pain free treatment for patients.
- Pedodontist can thus provide the most modern and most natural treatment available to their patients without fear that they may cause any physical or mental trauma

OZONE TOXICITY (4)

Ozone inhalation can be toxic to the pulmonary system and other organs. Complications caused by ozone therapy are infrequent at 0.0007 per application. Known side-effects are:

- Epiphora,
- Upper respiratory irritation
- Rhinitis
- Cough
- Headache,
- Occasional nausea, vomiting
- Shortness of breath
- Blood vessel swelling
- Poor circulation
- Heart problems.

CURE FOR OZONE INTOXICATION:

- The patient must be placed in the supine position
- Treatment with vitamin E and n-acetylcysteines.(2)

CONTRADICATIONS (1,2)

- Pregnancy.
- Glucose-6-phosphate-dehydrogenase deficiency (favism).
- Hyperthyroidism.
- Severe anemia.
- Severe myasthenia.
- Acute alcohol intoxication.
- Recent myocardial infarction.
- Hemorrhage from any organ.
- Ozone allergy.

CONCLUSION:

Dentistry is changing as we are now using modern science to practice dentistry. Ozone therapy provides a treatment modality with considerable benefits for dental patients of all ages. . The elucidation of molecular mechanisms of ozone further benefits practical application in dentistry. It is applicable to a wide range of conditions of the intra-oral hard and soft tissues. The treatment of carious lesions is effective and made much more acceptable for the patient. This makes it especially relevant to the younger patient and also for the elderly, who may have medical problems, which may complicate conventional dental treatment. Treating patients with ozone therapy reduces the treatment time with a great deal of difference and it eliminates the bacterial count more precisely. The treatment is completely painless and increases the patients' acceptability and compliance with minimal adverse effect.

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